Chemistry 129.01, Spring 2017, General Chemistry

Week #13

Class Meetings:

Wednesday, May 3. We consider the nature of energy, the forms it takes and energy changes associated with chemical processes. We will also explore the First Law of Thermodynamics and examine enthalpies of reaction, enthalpies of formation and Hess's Law.
Reading: OpenStax 5.1-5.3

Friday, May 5. Quiz #10: Buffers and Titrations.

We will discuss calorimetry and measure the heat flow of a dissolution process.
Reading: OpenStax 5.2

Assignments

Problem Set #13 - Due Monday, May 8th (at the beginning of class). Late homework will not be accepted.

1. For the following processes, calculate the change in internal energy of the system and determine whether the process is endothermic or exothermic:

   (a) A balloon is heated by adding 850J of heat. It expands, doing 382J of work on the atmosphere.
   (b) The system releases 255J and expands from 0.5L to 3.5L against an external pressure of 1.1 atm.
   (c) A chemical reaction releases 6.47kJ of heat and does no work on the surroundings.

2. (a) Under what conditions will the enthalphy change of a process equal the amount of heat transferred into or out of the system?
   (b) During a constant pressure process the system absorbs heat from the surroundings. Does the enthalpy of the system increase or decrease during the process?

3. When solutions containing Ag^+ ions and Cl^- ions are mixed, silver chloride precitates:

   $$Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)} \qquad \Delta H = -65.5kJ$$

   (a) Calculate ΔH for the production of 0.200mol of AgCl for this reaction.
   (b) Calculate ΔH when 0.150mmol of AgCl dissolves in water.

4. Given the following data:

$N_{2(g)} + O_{2(g)} \rightarrow 2\ NO_{(g)}$ $\Delta H = +180.7kJ$

$2NO_{(g)} + O_{2(g)} \rightarrow 2\ NO_{2(g)}$ $\Delta H = -113.1kJ$

$2N_2O_{(g)} \rightarrow 2\ N_{2(g)} + O_{2(g)}$ $\Delta H = -163.2kJ$

use Hess's law to calculate ΔH for the following reaction:

$$\mathbf{N_2O_{(g)} + NO_{2\ (g)} \rightarrow 3\ NO_{(g)}}$$

5. Using values from the appendix, calculate the value of the standard enthalpy change for each of the following reactions:
   (a) $4\ HBr_{(g)} + O_{2(g)} \rightarrow 2\ H_2O_{(l)} + 2\ Br_{2(l)}$
   (b) $CaO_{(s)} + 2\ HCl_{(g)} \rightarrow CaCl_{2(s)} + H_2O_{(g)}$
   (c) $4\ NH_{3(g)} + O_{2(g)} \rightarrow 2\ N_2H_{4(g)} + 2\ H_2O_{(l)}$
   (d) $Fe_2O_{3(s)} + 6\ HCl_{(g)} \rightarrow 3\ H_2O_{(g)} + 2\ FeCl_{3(s)}$

6. Two solid objects, A and B, are placed in boiling water and allowed to come to temperature there. Each is then lifted out and placed in separate beakers containing 1000g of water at 10.0°C. Object A increases the water temperature by 3.50°C; B increases the water temperature by 2.60°C.
   (a) What object has the larger heat capacity?
   (b) What can you say about the specific heats of A and B?

7. The specific heat of ethylene glycol is 2.42 J/(g.°C). How much J of heat are needed to raise the temperature of 62.0g of ethylene glycol from 13.1°C to 40.5°C?

8. When a 3.88g sample of pure ammonium nitrate dissolves in 60.0g of water in a coffee-cup calorimeter, the temperature drops from 23.0°C to 18.4°C. $\mathbf{NH_4NO_{3\ (s)} \rightarrow NH_4^+{}_{(aq)} + NO_3^-{}_{(aq)}}$

   (a) Calculate ΔH (in kJ/mol of NH_4NO_3) for the dissolution process Assume that the specific heat of the solution is the same as that of pure water.
   (b) Is this process endothermic or exothermic?

9. A 1.800g sample of phenol (C_6H_5OH) was burned in a bomb calorimeter whose heat capacity is 11.66kJ/°C. The temperature of the calorimeter plus contents increased from 21.36°C to 26.37°C.
   (a) Write a balanced chemical equation for the bomb calorimeter reaction.
   (b) What is the heat of combustion per gram of phenol? Per mole of phenol?